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Chapter 6: A Supplier Study at STS

6.1. Introduction

This chapter describes the third iteration of the AR cycle at STS. With over 300 years of experience in producing the world's finest tool steels, the group is committed to research and development so that STS materials meet the needs imposed by changing technology and the competitive market. STS Singapore, with more than 30 years of local presence, also adapts to a dynamic environment through continuing this focus on investment and development of facilities as well as services.

The main goal of this third iteration of the AR cycle, from a research perspective, is to conduct a study at the entity level, i.e. supplier. STS is one of the key suppliers of tool steel products to MAK. STS, being a downstream supplier of products to finished goods manufacturer like MAK, is compelled by business economics and competitive pressures to be synchronized with MAK.

The entire STS organization is involved in this AR iteration with some participation from sales department of MAK i.e. customer of STS.

6.2. Diagnosing

STS Singapore houses the latest technologies and expertise at their 6,400-sq.m facilities. STS strive to be the best in the supply of quality products with high value added services. STS close relationship with customers (i.e. manufacturers) is a cornerstone to the success in established markets. STS philosophy is to add value to these partnerships by growing with the customers changing needs.

STS professionalism is also founded on a commitment to provide only the finest quality services to customers and optimizing yields from existing resources. STS customers depend upon consistent expertise and premier products throughout the manufacturing process, heat treatment and machining services to ensure that they attain the highest overall profitability i.e. STS strive to operate at a maximal economy of return.

Tool users enjoy pre-production technical expertise and prompt service. They also appreciate that tools manufactured from STS products are known for their durability; resistance to chipping; cracking and tool

failure. These superior features reduce production stoppages and maintenance costs during production runs at customer plants.

The company has been a user of ERP from SAP. Functional areas of the enterprise are integrated to reduce redundancies and inaccuracy in data recording and reporting. STS has a focus on the operational and performance aspects of their supply chain. Business processes to be reviewed and re-engineered to reduce delay in customer services response. The goal is to synchronize the internal operations of STS to the customer's (i.e. MAK).

At the start of this AR iteration, the managing director of STS shared his frustration that despite having invested S\$ 12 million in an AS/AR (Automated Storage & Retrieval) system, STS *is not able* to determine upon receipt of a customer order, with confidence that the order could be fulfilled. Also, if the order could not be fulfilled, is STS *capable* to fulfill the order within the constraints of time and cost, based on MPS and MRP? There are many people involved from different departments and there seems to be a lot of redundancy, in the customer order confirmation and MPS processes. Customer services team is not able to make a qualified promise to customers at order taking on item availability i.e. ATP and CTP.

6.3. Action planning

It became evident in the early stages of my study at STS that there is a need for workflow automation now that the ERP system is already in place. Workflow automation will help to address issues of redundant data capturing, single-source (repository) of planning data and production capacity. Workflow automation should provide an operating environment that enables STS to synchronize with MAK processes whilst providing tools that allow for customization of workflows and processes.

The following key features are deemed necessary:

- a) Graphical user interfaces,
- b) Multi-media capabilities,
- c) Complete cross referencing drill down to activity,
- d) Online documentation,
- e) Project and decision support,
- f) Workflow management and messaging
- g) Security control.

The following goals are to be achieved:

- a) Automate STS business processes,
- b) Collaborate with customers,
- c) Deliver accurate quotes fast,
- d) Reduce operating costs,
- e) Optimize labor efficiency,
- f) Better plan and utilize capacity,
- g) Minimize returns and rework,
- h) Become more profitable

6.4. Action taking

The Customer Relationship Improvement (CRI) team is formed at the start of this AR iteration. Andrew Lim the Production Manager is appointed Project Leader. Based on the broad guidelines by the MD, the CRI team selected all four events and interactions of STS, related to performance management of supply chain to be studied (please refer to Appendix: A). The 4 main events are:

- a) Customer Order Processing,
- b) Production Planning,
- c) Purchasing and
- d) Shipping.

Andrew as Project Manager (reporting directly to MD), formed workflow teams for each event.

See Table 6.1 below, during the assessment stage, the events that are selected for mapping as detailed workflow models. These models are then returned to the workflow teams as attachment to messages. During the Implementation stage, with a few exceptions, all activities are performed with workflow automation. All orders and change request and response from/to the customer i.e. 3,050 in total are recorded in the workflow database.

Table 6.1: Events Summary Table

Event ID	No. of Different Workflows	No. Of Users	Mean Cycle Time (hrs)	No. of Sites	No. of Departments	No. of Workflow Messages	No. of Oral Contacts
STSE1 (Sales)	8	18	21	2	3	850	150
STSE2 (Planning)	12	26	48	1	2	750	250
STSE3 (Purchasing)	15	22	24	5	4	800	200
STSE4 (Shipping)	6	10	42	1	2	650	350

6.5. Evaluating

Eight dependent variables are identified in this study. Three dependent variables are related to the entity unit of analysis, namely: *workflow cycle time*, *demand for leadership skills* and *cross functional integration*. Another four variables are related to the individual unit of analysis, namely: *individual satisfaction*, *individual commitment*, *individual response time* and *individual learning (i.e. action learning)*. The one remaining dependent variable is related to the network unit of analysis, namely: *message & response quality*.

Data related to each of the 8 dependent variables is discussed next, along with the impact of workflow automation on the enabling cost of workflows for supply chain coordination. This 9th dependent variable *enabling cost* of workflows is not identified as a dependent variable in any of the causal models built during this research iteration. Nevertheless, the impact on this variable is analyzed separately in this section. This is done for two reasons:

- a) This impact is seen as “drastic” by most of the respondents, which I believe is particularly due to the high functional and site heterogeneity,
- b) Data on savings (or cost reduction) from the use of workflow automation are readily available at STS, and are seen as relevant for the discussion of workflow automation effects on one of the main independent variables of this study i.e. the anchor variable *synchronization effectiveness*.

6.5.1. Workflow Cycle Time

The analysis of structured interviews indicates that nearly 76 per cent of the respondents thought that workflows are completed in less time (measured in number of days) than conventional paper workflows (see Table 6.2). The main reason given by the respondents is a reduction in *message delivery and reaction time*, particularly in workflow involving staff from different functions (departments) and sites.

Message delivery and reaction time generally described by respondents as the time needed to get a message (request) to the right parties, including the recipients acting upon the message i.e. a chain of reactions (alternative actions to be evaluated by participants of the workflow). Several respondents noted that workflow cycle time tends to increase with *cultural and language* heterogeneity.

Table 6.2: Effects on Workflow Cycle Time

Answer	Frequency	Percentage (%)
Decrease	58	76.3
Increase	8	10.5
Had No Effect	9	11.8
Do Not Know	1	1.3
Total No. of Respondents	76	

Interestingly, cultural and language (site) heterogeneity in the CRI team formed at STS seems to be strongly correlated with functional (departmental) heterogeneity, a phenomenon that is in our view strongly influenced by the choice of events selected for workflow modeling and deployment. *This is confirmed by a correlation test between the numbers of departments and sites involved in the workflows shown in Table 6.1. The Pearson correlation coefficient obtained from this test was $r = 0.97$ (Refer to Appendix F for details), which suggest a strong correlation between number of departments and number of sites in the workflows studied.*

When asked about the influence of workflow automation on participants from the same site, but not necessarily working in the same room, most respondents indicated that workflows would still be completed in less time. The main reason given is that there is less functional disruption and not having to adapt their individual timetables to accommodate a face-to-face meeting.

About 10 per cent of the respondents (only 8 respondents) thought that workflow automation will take longer than conventional paper workflows. These respondents are unanimous in their explanation. As one of them put it in a structured interview: *“Individually, (it is) probably faster to route a workflow than ring around [i.e. telephone]. However, I have no idea how long it will take people to read their inbox messages and respond. Sometimes this is where the delays are caused and it can work out quicker to just call them”*.

That is, according to these respondents’ perception, the individual response time can be higher in workflow automation. Members may take longer to respond to electronic messages than to verbal request for opinions and information made over the telephone or in a face-to-face meeting (see Table 6.3, below). The mean individual response time to a workflow messages (STS.E1) in this AR iteration, was approximately 5 hours. The mean response time in a face-to-face meeting is almost immediate (feedback). This comparison does have a considerable impact on the respondents’ perceptions of workflow automation on individual response time.

Table 6.3: Effects on Response Time

Answer	Frequency	Percentage (%)
Decrease	9	11.8
Increase	49	64.5
Had No Effect	18	23.6
Do Not Know	0	0
Total No. of Respondents	76	

As our research focus is on strategic performance management of supply chains; *workflow cycle time* (see Table 6.4, below) is seen as taking precedence over individual response time and therefore more significant in the discussion of the workflow automation effects on one of the main anchor variables i.e. *synchronization efficiency*.

Table 6.4: Mean Workflow Cycle Time

Event ID	Mean Cycle Time w/o Workflow (hrs)	Mean Cycle Time with Workflow (hrs)	Difference Percentage (%)
STS.E1 (Sales)	48	21	56
STS.E2 (Planning)	54	48	11
STS.E3 (Purchasing)	60	24	60
STS.E4 (Shipping)	48	42	13

6.5.2. Demand for Leadership Skills

Data analysis seems to suggest that workflow automation reduces the demand for leadership skills in coordinating and expediting in supply chain. These leadership skills can take different forms, such as the ability to solve conflicts and to coordinate the work of autonomous entities in the supply chain. It is not our goal to precisely define and measure the main components of leadership skills, but rather to assess respondent's general perceptions about workflow automation effects on leadership skill requirements. Statements of two key, workflow team leaders, who admitted having had severe difficulties in the past when they had to lead face-to-face meeting (on problem solving coordination and expediting) supported the perception that there is a decrease in the demand for leadership skills. Those difficulties are, in their view, *completely eliminated* by workflow automation.

Unstructured interviews indicated that the above effect may have been linked with two other workflow automation effects. One of these effects is called *hierarchy (boundary/barrier) suppression* i.e. the suppression of barriers to free communication due to hierarchy differences (Josserand, 2004). The other effect is a reduction of *individual influence* by workflow automation. Over 71 per cent of structured interview and questionnaire respondents are of the opinion that workflow automation suppresses hierarchy barriers in workflows (see Table 6.5, below). Some of them stated that, as subordinates, they feel less constrained by their managers.

Table 6.5: Effects on Barriers Suppression

Answer	Frequency	Percentage (%)
Decrease	54	71
Increase	049	0
Had No Effect	12	15.7
Do Not Know	10	13.1
Total No. of Respondents	76	

Approximately 45 per cent of the respondents feel that individual member influence on proceedings in coordination and expediting is reduced in workflow automation (see Table 6.6, below). Individual influence may be unrelated to managerial level, resulting from other factors such as oral communication skills and physical appearance. The main explanation given by respondents for both hierarchy suppression and lower individual influence in workflows is the relative perceive "anonymity" present in workflow automation. Some respondents' noted that this "anonymity effect" is still present when team members know each other well (e.g. participants from different departments who meet periodically).

Table 6.6: Effects on individual influence

Answer	Frequency	Percentage (%)
Decrease	34	44.7
Increase	8	10.5
Had No Effect	22	28.9
Do Not Know	12	15.7
Total No. of Respondents	76	

However, about 11 per cent of the respondents suggest that individual influence could be increased in workflows, particularly when members know each other well, because authoritarian and confrontational individuals would feel less constrained to try and impose their will on others than they would in face-to-face meetings.

6.5.3. Message and Response Quality

Approximately 80 per cent of the respondents are of the opinion that the quality of Message and response has been increased by workflow automation; whereas only 5 per cent of the respondents feel that workflow automation has no effect on this attribute. Conversely, approximately 8 per cent of the respondents thought that the, "quality of

response” has been decreased by workflow automation (see Table 6.7, below).

The main reasons given by the respondents for the increase in message and response quality are lower stress and disruptions, higher individual contribution quality, higher issue focus, lesser “going back and forth” to seek clarification and easier referencing of related information than in telephone and fax communication.

Table 6.7: Effects on message and response quality

Answer	Frequency	Percentage (%)
Decrease	5	6.5
Increase	61	80.2
Had No Effect	6	7.8
Do Not Know	4	5.2
Total No. of Respondents	76	

The main reason provided for the decrease in response quality is the lower team participation. According to the respondents the lower control over individual participation in workflow automation, when compared with face-to-face meetings, is also the main cause for the decrease in team participation stress perceive by individuals. This effect is seen as positively affecting the quality of individual contributions in combination with another factor - *the inherently better quality of written over verbal responses*.

The influence of this factor is also observed during the facilitation of expediting late orders. In some cases, for example, participants and managers noted that the process of writing about late orders and constraint processes improves the understanding and communication of production department problems i.e. allowing for all variables to be considered, in comparison with only speaking about the problems.

Approximately 63 per cent of the respondents thought that change adoption (e.g. engineering change notice) is higher in workflow automation than in conventional phone, fax or email based communication. About 26 per cent did not know whether change adoption is increased or decreased by workflow automation. This uncertainty is in our view cause by difficulties on the part of the respondents in understanding what the concept of change adoption meant. None of the respondents thought that change adoption is lower, that is, the remainder of the respondents thought that workflow automation has

no effect on change adoption or did not know how to respond (see Table 6.8, below).

Table 6.8: Effects on Change Adoption

Answer	Frequency	Percentage (%)
Decrease	0	0
Increase	48	63.1
Had No Effect	8	10.5
Do Not Know	20	26.3
Total No. of Respondents	76	

Participant observation notes and transcripts of workflow interactions seem to confirm the positive influence of workflow automation on change adoption, and point to a similar influence on goal focus. It is evident in this iteration that workflow automation drastically reduced workflow cycle time (as illustrated in Table 6.4, above).

Also, workflow automation enables workflow progress tracking, proactively non-intervention triggering of action request based on pre-set parameters and escalation rules. Some workflow participants noted that such practices could hardly be achieved without workflow automation. Without such tracking enablement, participants of workflows could get their priorities wrong or “forget” verbal commitments. Resulting in disruptions and causing “ad-hoc” execution of activities, consequently leading to a higher level of complexity in scheduling and chaos on the production floor.

As with change adoption, approximately 83 per cent of the respondents’ thought that coordination related *information access* is increased in their workflow automation, in comparison with conventional phone, fax and email based communication (see Table 6.9, below). This indicates that members perceive an increase, due to workflow automation and in their ability to fetch information that (they felt) is necessary for them to effectively execute the coordination and expediting activities.

Again the small proportion of respondents (13%) who "did not know" how to answer this question, in our view, is due to the abstract nature of the concept of workflow/process related information access (which was pointed out by most of the 10 undecided respondents).

Table 6.9: Effects on Information Access

Answer	Frequency	Percentage (%)
Decrease	0	0
Increase	63	82.8
Had No Effect	3	3.9
Do Not Know	10	13.1
Total No. of Respondents	76	

Although some members perceive this increase in information access as likely to increase response quality, participant observation and unstructured interviews suggested that the written message and response quality can decrease due to cultural and language heterogeneity, or when action oriented task are being communicated.

In some workflow messages, the sales or engineering staff seems to omit necessary information, assuming that the purchasing and production staff would fetch it on their own if required during the workflow life cycle. As a result, some staff simply refrained from participating, as opposed to seeking further clarification of unknown terms or concepts, for example. According to one such group member: “... *(in workflow automation), if someone starts writing about things you don't know, you are turned off ... in a face-to-face meeting you can ask that person for the meaning (of a term or concept) during a coffee-break, for example....*”

Interestingly, the respondent who provided the comment quoted above noted that he would not feel inclined to ask for a clarification in a face-to-face meeting, because he feels that the other members could see this as a lack of functional competence on his part. He believes that the open admission of lack of process-related knowledge or information in his workplace could be damaging to the perception (of himself) that his bosses and peers hold. He would rather try and ask for a clarification during a coffee break by approaching the person who brought up the issue individually and as privately as possible.

The higher quality of written inputs from members, mentioned as a positive factor in the “Increase in the quality of individual contributions”, seems to be associated with an increase in the effort that an individual has to put into contributing to their workflows, in comparison with face-to-face meetings. Some respondents, for example, pointed out the need to better structure and clarify ideas when writing electronic messages to the group to avoid misinterpretations. This may require word processing skills (e.g. to cut and paste text parts, generate and attach graphs to a

message, or save messages for later use), which in turn seems to be one of the reasons why individual participation is reduced, especially amongst older employees.

A few responses quoted from structured interview transcripts seems to suggest that some individuals are more likely than others to refrain from contributing postings, by noting that "...*slow and unsure mouse users can be put off by workflow automation...*", and that "...*computer illiterate folk are unlikely to participate in the workflow activities...*"

The response frequency analysis indicates a slight trend towards an "increase in member access to pertinent process-related information". However, there is no indication from the analysis of responses to structured or unstructured interviews that workflow automation increased the total amount of information (or knowledge) exchanged by individuals. Qualitative evaluation from a communication perspective of face-to-face meeting, suggests that verbal contribution requires less individual effort, equivocality can be reduced by almost immediate feedback on the comprehension of the message, broader scope of discussion and lesser threat of repercussions of the spoken word. Workflow automation tends to be focus on the subject matter of discussion; the written word requires more individual effort and has greater implication than spoken words. All pointing, to a decrease in information and therefore knowledge, exchange between individuals.

On the other hand, a cognitive evaluation of face-to-face meeting, suggests that all verbal information gathered during the meeting cannot be committed to memory (i.e. Short term memory). Some kind of note taking e.g. summary has to be devised to ensure that information gathered is not lost. Especially, that recall and application may take place after long time intervals. Workflow automation characteristics are suited for information storage and retrieval without any loss of quality. This can be seen as suggesting that individuals can store and recall (retention) larger amounts of information and therefore knowledge in workflow automation than face-to-face meetings.

6.5.4. Individual Satisfaction

Although about 38 per cent of the respondents perceive no workflow automation effect on their personal satisfaction from participating in their workflows, approximately 29 per cent of the respondents pointed out that their satisfaction decreased because of the workflow automation (see Table 6.10, below). The most frequent explanations for this effect are

lower personal contact, lower member participation (or team interaction), and greater effort that an individual has to put into compiling messages and response, in comparison with face-to-face meetings.

My participant observation notes suggests individuals experience frustration whenever they get an incorrect response to their workflow messages (possibly due to misinterpretations) or a request for more information, when individuals have already spent hours on compilation of the workflow message i.e. attachments with relevant information, summarization and proof reading.

As shown before in this chapter, apparently these negative characteristics are observed with certain frequency in individual responses in all workflow teams. A further analysis of discussion transcripts suggests that these characteristics are present particularly in the early stages of workflow deployment at STS.

Table 6.10: Effects on Individual Satisfaction

Answer	Frequency	Percentage (%)
Decrease	22	28.9
Increase	25	32.8
Had No Effect	29	38.1
Do Not Know	0	0
Total No. of Respondents	76	

Conversely, about 33 per cent of the respondents thought that their satisfaction is increased due to workflow automation. The three main explanations given by these respondents are workflows are less disruptive, allow for a better distribution of contributions (inputs from all participants), and are less stressful on individuals than equivalent face-to-face meetings.

Some respondents also pointed out that the workflow automation allows for more interaction between staff from different departments and sites, because several communication barriers are removed, such as distance and different time schedules. This, in the opinion of these respondents, leads to a higher social interaction than if they had to rely only on face-to-face interaction, even though this extra interaction lacked "social" contact to some extent. This extra interaction in turn leads to an increase in member satisfaction according to these respondents.

6.5.5. Individual Commitment

Approximately 72 percent of the respondents are of the opinion that workflow automation contributes to a higher individual commitment to response quality in their daily execution of work, in comparison with no workflow automation (see Table 6.11, below). The most frequent explanation presented for this is a better distribution of information within the organization, enabled by workflow automation.

Table 6.11: Effects on Individual Commitment

Answer	Frequency	Percentage (%)
Decrease	10	13.1
Increase	55	72.3
Had No Effect	11	14.4
Do Not Know	0	0
Total No. of Respondents	76	

A few respondents mentioned change adoption as one of the success factors in individual commitment. Although not an intuitive effect, my research data about the workflow message and response quality suggests that an effective change adoption may have an influence on coordination success. This research data is obtained within a month of each workflow deployment, through unstructured interviews with the leaders, regarding the success of their workflows.

But does team interaction not play an important role in the individual commitment to team goals? According to Social Development Theory (Vygotsky, 1978), it does. The major theme of Vygotsky's theoretical framework is that social interaction plays a fundamental role in the development of cognition. Vygotsky states: *"Every function in the child's cultural development appears twice: first, on the social level, and later, on the individual level; first, between people (inter-psychological) and then inside the child (intra-psychological). This applies equally to voluntary attention, to logical memory, and to the formation of concepts. All the higher functions originate as actual relationships between individuals"* (pp. 57). If there is any correlation between change adoption and degree of interaction, it may have been offset by other factors (Lerner, 2001). It appears from interviews and participant observation notes that, in the successful workflow teams, commitment is high from those who have to implement the change, typically some or all of the participants.

However, as approximately 13 per cent of the respondents pointed out, individual commitment may be decreased by workflow automation. These respondents are unanimously of the opinion that commitment is decreased among those who do not actively participate or have little active participation in the workflow deployment. Some respondents pointed out, more specifically, that the lower the individual's active participation in the workflow, the lower would be his or her commitment to work at “staying synchronized” with others in the supply chain.

6.5.6. Individual Learning (Action Learning)

Half of the respondents thought that action learning is higher in workflows, in comparison with similar interactions where workflow automation is not available (see Table 6.12, below). Respondents split learning into social learning and process or technical learning (Haines, 2000). Social learning is the learning about other member's perspectives and ideas. Process learning is the learning about the workflows targeted by the team for automation. The main reason suggested by respondents as causing the increase in individual learning is the higher sincerity and quality of individual contributions (inputs from all participants) in workflow team.

Approximately 7 per cent of the respondents, on the other hand, thought that member learning is reduced when using workflow automation. The main reason presented is the lower team interaction in workflow automation than in similar face-to-face meetings. One of the respondents also explained the reduction in member learning by noting that, unlike workflow automation, face-to-face meetings allow for additional informal conversations where social and process learning occurs.

Table 6.12: Effects on Individuals Learning

Answer	Frequency	Percentage (%)
Decrease	5	6.5
Increase	39	51.3
Had No Effect	20	26.3
Do Not Know	12	15.7
Total No. of Respondents	76	

A few respondents pointed out that member learning is also increase by the broader functional and process representation in workflows fostered by workflow automation. The explanation behind this perception,

according to these respondents, is that if one can involve more functional and process representation in a workflow. Then one can increase the scope of learning of participants in the virtual team (Kintu, 2003). Workflow automation, according to these respondents, made it easier for prospective participants from different functions to be included in the workflow data model. This is strongly supported by the frequency distribution of responses to the question of whether workflow automation fosters functional heterogeneity in workflows, as summarized in Table 6.13, below.

Table 6.13: Effects on functional heterogeneity

Answer	Frequency	Percentage (%)
Decrease	0	0
Increase	71	93.4
Had No Effect	3	3.9
Do Not Know	2	2.6
Total No. of Respondents	76	

The main reason for the increase in functional heterogeneity, according to the respondents' perception is the decrease in the functional disruption fostered by workflow automation. One can speculate based on this perception that the difficulty of matching face-to-face meetings and individual timetables increases with the number of different departments represented in the coordination and expediting process.

6.5.7. Organizational Enabling Cost

Approximately 87 per cent of the respondents are of the opinion that the operational cost of running coordination and expediting is reduced when workflow automation is available, in comparison with similar phone, fax and email based coordination and expediting (see Table 6.14, below). Most of the respondents perceive the cost reduction as "drastic". Reasons given are no travel and accommodation costs in groups involving members from different sites, lower participant function disruption, and lower individual participation cost, in comparison with similar conventional coordination and expediting means.

Table 6.14: Cost of Workflows

Answer	Frequency	Percentage (%)
Decrease	66	86.8
Increase	1	1.3
Had No Effect	2	2.6
Do Not Know	5	6.5
Total No. of Respondents	76	

The argument presented by respondents in favor of the perception is that the goal of workflow automation is not simply coordination or expediting. Workflows are typically formed around a set of existing processes and procedures concerning product, service, quality and productivity (term here as a “problem” to be solved). The urgency in the solution of these problems for the organization is described as a success factor in supply chain improvement (Gang Yu & Xiangtong Qi, 2004). The commitment of staff time to “coordination” activities, however, can worsen these problems, and thus reduce efficiency and productivity even further.

As an example, consider an ERP II system; that is a massive, technically complex computer system that spans an entire organization. The main goal of the system is to reduce unproductive work. However, work would likely increase, at least initially, if some staff in the department stopped performing their functional activities and participate in ERP implementation meetings (Firestone, 2003). Some aspects of enterprise coordination may be improved by implementing complex systems. However, making these systems run smoothly on a daily basis is a huge coordination challenge of its own (Khosrow, 2003). As different functions are more tightly linked together, the new dependencies between functions have to be coordinated.

Some respondents’ perceive workflow automation as likely to mitigate this problem (i.e. commitment of staff time to “coordination” activities) by reducing the time staff has to commit to face-to-face discussion, as well as allowing staff to participate in the discussion at a convenient time (addressing the exception conditions only).

Unlike the reduction in individual function disruption, the argument presented by respondents for a reduction in individual participation costs due to workflow automation is a more direct one, and is easy to verify based on some estimated figures. The average time that would have to be spent by each individual in coordination and/or expediting group

discussion is estimated, (as a result of approximately 17 unstructured interviews) to be slightly over 20 hours if the discussions are carried out exclusively through face-to-face meetings. This time is reduced by workflow automation to approximately 5 hours. This amounts to a reduction of approximately 75 per cent in the participation time.

By the same token, I could conclude that the average time spent by workflow team leader is reduced from 20 hours to about 3 hours, according to my own estimates matched against that of the Team leader’s records. This amounts to an 85 per cent reduction in the coordination and expediting team participation time.

See Table 6.15 below, considering that the staff costs the organization on average 180 dollars an hour (STS per man-day rate), and that the number of individuals involved in a workflow is 18 (STS.E1), than workflow automation reduced the organization’s expenditure per event.

Table 6.15: Cost Comparison

Cost Type	W/O Workflow Automation	With Workflow Automation
Participants = 18 (STS.E1)	$180 * 20 * 18 = 64,800$	$180 * 5 * 18 = 16,200$
Team Leaders = 1 (STS.E1)	$180 * 20 * 1 = 3,600$	$180 * 3 * 1 = 540$

It is important to stress that this reduction considers only time-savings and therefore is likely to apply to a broad range of workflows. It disregards, however, other types of costs such as travel expenses, which can make the reduction in cost an even more significant advantage of workflow automation.

6.6. Research iteration impact on the organization

At the end of the research iteration, Andrew as project manager prepared a summarized report that is submitted to the senior executives involved in the workflow deployment and, subsequently to all participants. The resulting feedback from participants suggests that most of them perceive the workflow automation as having benefited the organization in four main distinct ways:

- a) By contributing towards increasing the quality (mostly) and productivity (to a lesser extent) of the workflows targeted by the workflow teams,
- b) by contributing towards increasing process-related knowledge and information between the different sites and departments involved in the workflow while the orders are in progress (mostly), and after the

workflows are completed to a lesser extent and with this effect waning over time,

- c) By contributing towards the formation of a customer relationship workflow integration with MAK (i.e. customer) culture in the organization; and
- d) By allowing workgroup leaders to learn through best practices adoption the planning and coordination skill set to eliminate “waste”.

In spite of the perceived benefits listed above, the workflow automation deployment is seen by some middle managers as *"...a waste of time, resources, and money..."* as one of them put it. Interestingly, these managers apparently shared some common personal characteristics. They are mostly "managers who came through the rank and file", in the jargon used at STS, in the sense that they are typically involved in direct production activities. They are also generally negative towards the use of computer technology, except for data management e.g. storing and maintaining data. They are generally both pragmatic and authoritarian according to the views of their subordinates. Participant observation field notes, on the interaction of these managers with their staff, in all cases, support these views.

Two middle managers perceive the research iteration as particularly beneficial to their areas. These managers have been involved as participants in the workflows and reported most of the organizational benefits listed above. One of these managers reported having modeled his own workflow for application of leave approvals and monthly expense claims of staff, doing away with paper forms, in his department.

The contrasting behavior of two senior executives towards the project is particularly puzzling to me. These two senior executives are the heads of the respective functional areas involved in workflow deployment. One of them appears to be very content with the organizational results of the workflow deployment. He believes, that workflow automation should be incorporated as a process into the routine activities of STS as a whole. He stated that *"...there is a place for collaboration (workflows automation) in our organization..."*, and stated his interest in setting up a full-blown project to involve all the suppliers of STS.

The other senior executive reacts in a very negative way to the CRI initiative, for what he considers as being an ineffective deployment. He appears to be determined to pose insurmountable obstacles for the deployment of an organization-wide workflow automation initiative (this executive is probably one of the STS more influential personality). His

reaction appears to be predominantly defensive, rather than motivated simply by a lack of confidence on the benefits likely to accrue from workflow automation. This defensive reaction may have been caused by a lack of political attention and “respect” from the workflow team early on in the deployment stage. For example, during the CRI team set up, the project manager pointed out a number of inefficiencies in several of STS processes. Further interactions with this senior executive confirmed that such “open-approach” is poorly aligned with what he considers to be a “politically correct” conduct.

6.7. Specifying learning

In accordance to the data analysis process described in Chapter 3, the results of the evaluation stage leads to the generation of explanatory causal models incorporating relationships between variables. The main independent variable in these models, as in the previous research iterations, is *workflow automation*. The dependent variables in the causal models are the ones described in the evaluation stage, plus the variable *cross functional integration* and the anchor variables *synchronization effectiveness*, *synchronization efficiency* and *synchronization competency*. From a strategic performance management of supply chain perspective, *Team formation for collaborative workflow* from the 2nd AR iteration has been re-conceptualized to include *barrier suppression*, *information access* and *enabling cost of workflows* to form cross functional integration.

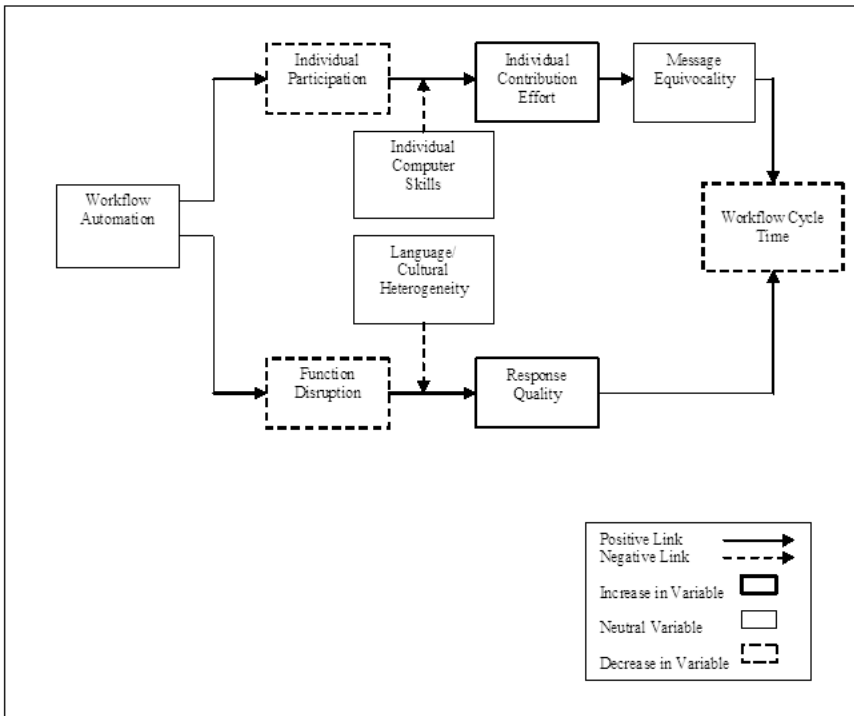
The remaining research variables in the initial research framework are either discarded, or incorporated in the causal models as intervening or moderating variables together with new variables identified during data analysis. These causal models are discussed next.

6.7.1. Workflow Cycle Time

The variable *workflow cycle time* seems to have been decreased by workflow automation according to structured interview respondents’ perception. Two variables seems to have affected *workflow cycle time*. One is *message equivocality*, which seems to be much reduced in workflow automation, than in conventional phone and fax communication in similar circumstances. *Workflow cycle time* seems to be directly affected by *message equivocality*, i.e. by the time that individuals comprehend the message completely and respond correctly to a workflow message (Koufteros et al., 2002).

Workflow cycle time also seems to be directly affected by *response quality*. Interview analysis suggests that the effect of the variable *response quality* could offset that of the variable *message equivocality* on *workflow cycle time*, particularly in workflows involving staff from different sites. This suggests the existence of a variable – *cultural and language heterogeneity* - moderating the influence of *response quality* on *workflow cycle time*. The causal links between these variables are represented in the explanatory causal model in Figure 6.1, below.

Fig 6.1: Path Diagram – Workflow Cycle Time



The effect of workflow automation on the variable *message equivocality* can be explained through the consideration of some intervening variables. Participant observation and interviews seems to suggest that *message equivocality* is influenced by the variables *individual contribution effort*, which reflects how difficult it is for a member to compile a workflow message, and *individual participation*, which reflects the control that other participant, particularly the manager, authorizes the subordinate to have.

An increase in individual contribution effort, combined with a decrease in individual participation control, apparently leads individuals to construct more thought out workflow messages. The effect of workflow automation, on individual effort to contribute seemed to be moderated by the variables individual *computer skills*, which influences the ability of a participant to interact with the workflow comfortably, and *individual computer literacy*, which is a function of the amount of knowledge that participant, holds particularly about how the supply chain and workflow system operates. Slow typists, for example, appear to usually take more time to compile, whereas those who are less skilled in the operating computers seem to refrain from participating.

Some participants indicated frustration of not knowing exactly when their messages would reach the other person. Message replication could take from some minutes to (in very rare occasions) as long as two days, due to faults in the workflow system, the local area network (LAN), or the main outlook exchange server (based in Hong Kong). Even though the status of the messages (e.g. pending, delivered, read) could be easily checked through the system, some participants seems to have difficulty in understanding the concept of "message status". These participants appear to be at the lower end of the computer literacy scale. I decided not to include the variable *individual computer literacy* in the explanatory model in Figure 6.1 because I believe that this variable is strongly correlated to the variable *individual computer skills*, that is, a participant at the low-end scale of computer literacy is unlikely to have high computer skills (although exceptions may exist).

Also important in reducing *workflow cycle time* seems to be the influence of the variable *function disruption*, i.e. disruption of a individual's routine activities due to participation in a coordinating or expediting meeting. In the respondents' view workflow automation decreases disruption of individuals' routine activities (i.e. activities that are related to individuals' organizational functions), an effect that appears to be completely independent of site (i.e. language and cultural) heterogeneity. On the other hand, a high correlation between site and departmental heterogeneity is found in the workflows conducted in this research iteration, and departmental heterogeneity seems to be correlated with the degree of individual function disruption caused by coordination and expediting activities.

However, the influence of the variable individual's *function disruption* on *workflow cycle time* did not seem to be a direct one. It seems to be mediated by the variable *message quality*. This can be better understood

with reference to face-to-face meetings. In this type of interactions, it is obvious that the variable “message quality” is directly affected by the variable *function disruption*, as the more disruption coordination meetings cause on an individual’s timetable, the less likely, that the individual will be available to attend meetings at short notice. Moreover, a further analysis of this influence leads to the realization that face-to-face meetings are very unlikely to come up with a proposed solution in only one meeting.

6.7.2. Demand for Leadership Skills

The variable *demand for leadership skills* seems to have been reduced by workflow automation (Woltring et al., 2003). The demand for leadership skills in CRI teams seems to be affected by the variable *individual influence* (see Figure 6.2, below).

Based on pattern matching of explanations given by respondents in structured interviews, that the variable *individual influence* is a good predictor of the variable *hierarchy (barrier) suppression* within the scope of analysis on variations in demand for leadership skills i.e. if individual influence is reduced, *hierarchy suppression* increases within this limited scope.

Therefore, only one of these two variables - *individual influence* - is consider in the explanatory causal model explaining the relationship between workflow automation and demand for leadership skills (Chiok, 2001). For a similar reason I also left the influence of oral communication skills out of this explanatory model, at least explicitly. While *individual influence* in face-to-face meetings may result from individual characteristics unrelated to managerial level, such as oral communication skills as an example, those characteristics are always possessed individually. In this sense, the influence associated to an *individual's* rank in the organizational hierarchy will be reduced by workflow automation in the same way as the *individual's* oral communication skills and body language.

Individual anonymity (i.e. individuals’ perceive sense of anonymity) seems to be a key variable in explaining the reduction in individual influence that occurs in workflow automation (Mathena, 2002). Another key variable is *individual participation control*. Perceive anonymity seems to increase with workflow automation, mainly due to the impersonal characteristic of workflow automation (Thurlow et al., 2004). The variable *individual participation control*, on the other hand, seems to

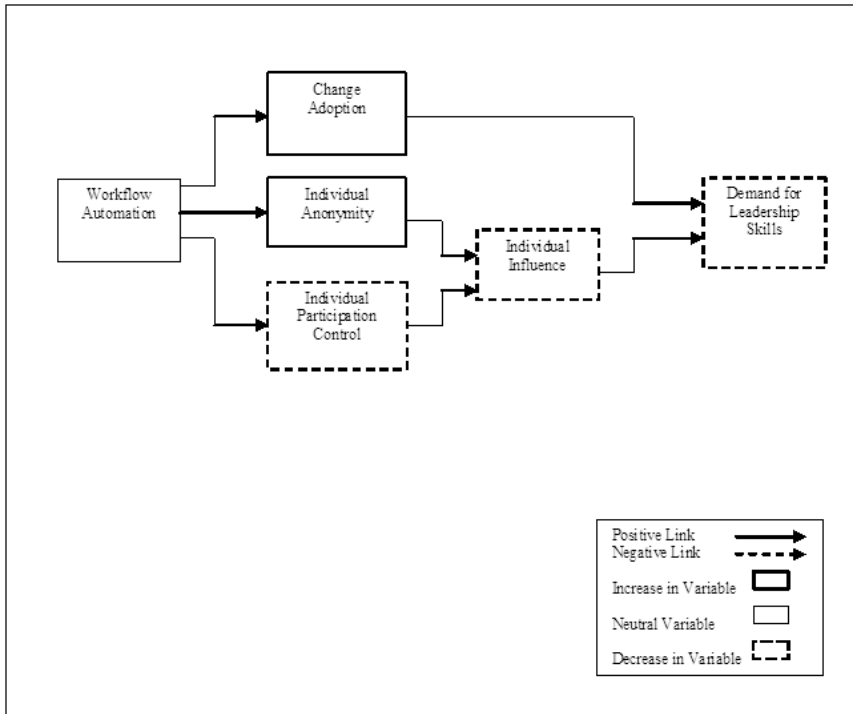
decrease with workflow automation, particularly due to the asynchronous nature of this communication technology (DiMicco et al., 2004).

When CRI team members interact asynchronously via workflow automation, they cannot be "pushed" into giving a response to a direct question or to contribute right away to the problem at hand, as often happens in face-to-face meetings (e.g. by directing a question to a particular individual).

I could not find any explanation to account for some of the respondents' belief that workflow automation can, in some cases, increase individual influence. In follow-up interviews with those respondents, though, they seem to associate that effect with the "bluntness" of some of the participants' response in their workflows. According to their view, such "blunt" comments would not happen in face-to-face meetings, where people are generally more polite and non-confrontational. That influence, however, did not seem to be disruptive from a coordination perspective, since the respondents' also stated that their goals and objectives of the workflow remained unchanged by those "blunt" comments.

During the data analysis of workflows transcripts it became clear that an important factor in the reduction of the demand for leadership skills has been the increase in the variable *change adoption*, fostered by workflow automation (Harris & Ogbonna, 2001). This perception is consistent with some of the workflow leaders' opinions about the positive influence of workflow automation on change adoption, mentioned earlier in the evaluating stage.

Fig 6.2: Path Diagram – Demand for Leadership Skills



6.7.3. Message and Response Quality

The variable *message and response quality* seems to be increased by workflow automation. Seven variables seem to directly affect the quality of response from CRI teams, namely *individual stress*, *departmental heterogeneity*, *site heterogeneity*, *individual interaction*, *individual contribution quality*, *team focus* and *information access*. *Individual stress* and *individual interaction* seemed to be lower in teams when workflow automation is present. Conversely, *departmental and site heterogeneity*, *individual contribution quality*, *team focus*, and *information access* seemed to be higher. The explanatory causal model in Figure 6.3 below depicts the relationship between workflow message and response quality.

Participant responses in interviews suggests that the variable *individual stress* is reduced mainly due to the lower individual participation control in workflow automation, a finding that is consistent with previous findings in the empirical literature on cognitive behavior (Pohl, 2004). A lower individual participation control, however, also appears to lead to a

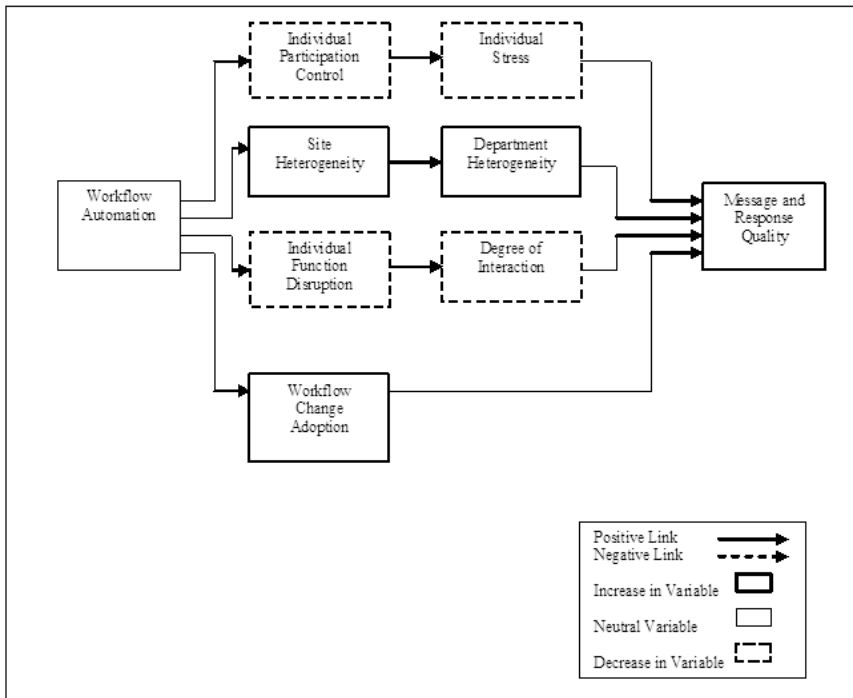
lower individual participation, as some workgroup members tend to give lower priority (*urgency*) to their participation in the workflow messages than to their routine functional activities, particularly if these individuals have low computer skills i.e. the variable *individual computer skills* plays a moderating role in the model. On the other hand, individual participation seems to be fostered by the lower individual function disruption in workflow automation.

Participant responses indicate that the variables *site (i.e. cultural & language) heterogeneity* and *departmental heterogeneity* directly influences *message and response* quality (Mudrack, 2003). Site heterogeneity seems to positively affect *message and response quality* because different offices have different perspectives of the same processes, since they run those processes in different geographical and regional settings. Workflow model standardization across different geographic and regional setting can facilitate workflow effectiveness.

Respondents also indicate that the influence of departmental heterogeneity on *message and response quality* can be moderated by the variable *problem complexity*. It seems that as complexity increased, so did the need for more interaction. In an unstructured interview, for example, a senior manager pointed out that workflow automation would be appropriate in workflows addressing "simple and routine" issues, but would fail in handling "complex" issues. That senior manager did not define complexity, but indicated that it may strongly correlate to the departmental heterogeneity in the workflow. In his view, the reason for this is that processes that cut across several departments (*boundaries*) are likely to be more complex than processes totally contained in one department only. He noted that this is probably compounded by the fact that staffs in different departments often have different knowledge backgrounds and different perspectives of the organization, which may lead to the use of different concepts and approach in framing the problem, thus increasing its complexity (Samii & Karush, 2004).

Departmental heterogeneity apparently has not been directly influenced by workflow automation. It appears that the variable *site heterogeneity* intervenes, particularly in a supply chain with a large number of entities spread over a large number of different sites. Another intervening variable seemed to be *function disruption*, since the functional diversity in workflows involving several different departments is likely to lead to a higher disruption of individual functional activities if those individuals have to meet face-to-face.

Fig 6.3: Path Diagram – Message and Response Quality



Following this line of reasoning a face-to-face interaction involving only IT support staff, for example, is likely to disrupt individual functional activities to a lower extent than if the interactions also involved quality control inspectors (or the customer’s incoming QC inspectors). This is because it seems to be generally more difficult to match timetables of staff from different departments than of individuals from the same department. Therefore, a lower individual function disruption fostered by workflow automation is likely to lead to a higher functional heterogeneity in the workflow (in this case, a moderating variable), if the coordination scope so requires.

The influence of workflow automation on the variable *individual contribution quality* seems to be moderated by the variable *individual computer skills*. Some workflow Team leaders and unstructured interview respondents seem to reasonably expect participants with good computer skills to more likely be contributing elaborate messages, whereas those individuals with poor computer skills to likely refrain from contributing or contribute only short messages with brief information.

A further analysis of STS workflow database, matched with participant observation notes, supports this perception to some degree.

The respondents' perception that the variable *team focus*, which is influenced by *change adoption*, positively affects the quality of the message and response and is consistent with the general assumption that when teams stray from their initial goal the quality of the team outcome in general tends to decrease. This assumption is supported by Katzenbach study on short-lifetime teams (Katzenbach, 2000).

The positive impact perceived by some respondents of information access to external workflow-related information (e.g. documents and archival records), reflected in the presence of the intervening variable *information access* in the model, is consistent with study-based assumptions about the benefits of workflow automation to distributed groups/virtual teams (Umar, 2003).

6.7.4. Individual Satisfaction

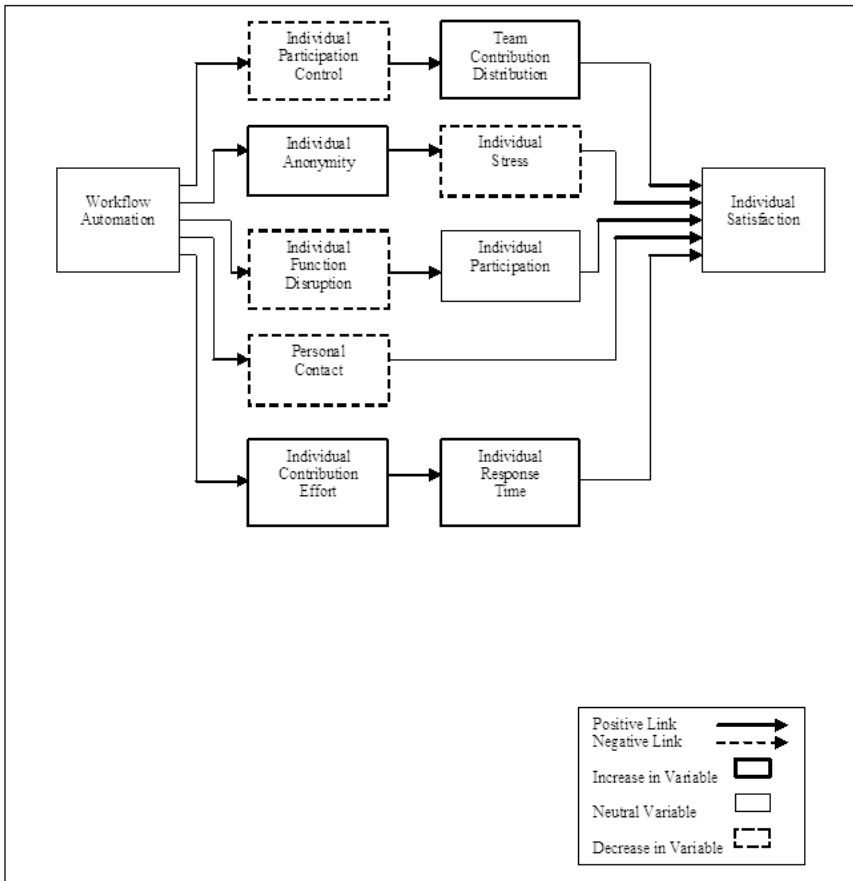
Individual satisfaction seems to be neither increased nor decreased by workflow automation. Six variables seemed to directly affect the variable individual satisfaction. These variables were *individual stress*, *team contribution distribution*, *degree-of-interaction*, *individual response time*, *function disruption* and *personal contact*.

Individual stress, workgroup interaction, function disruption, and personal contact appears to decrease with workflow automation; Team contribution distribution, and individual response time appears to increase. The causal links between these variables are shown in the explanatory causal model in Figure 6.4, below.

The reduction in the variable *individual stress* appears to be caused by two workflow effects i.e. an increase in individual anonymity and a decrease in individual participation control. The reduction in the variable *degree of interaction*, on the other hand, seems to be caused by a decrease in member participation, which in turn appears to be linked to both an increase in individual contribution effort and a decrease in individual participation control in workflow automation, in comparison with similar face-to-face interactions. As discussed previously in this chapter, the impact of workflow automation on individual contribution effort appears to be moderated by the variable *individual computer skills*.

The evidence obtained from interviews and participant observation suggests that both variables *function disruption* and *personal contact* decrease with workflow automation. The impact of workflow automation on *function disruption* has been discussed before in this section, when I made considerations regarding the variable *workflow cycle time*.

Fig 6.4: Path Diagram – Individual Satisfaction



The negative impact of workflow automation on *personal contact* can be explained by the fact that people tend to use the workflow system for most of their work, which is indicated by the proportion of workflow automation and oral communication in the teams in Table 6.1 above, and by the fact that individuals used the workflow system for most interactions and only resort occasionally to face-to-face meetings and the telephone.

The higher proportion of coordination and expedition activities is perhaps motivated by the benefits accruing to team from the use of workflow automation, such as reduction in *function disruption* and *workflow cycle time*. This, in turn, leads to lower *personal contact* between individuals. Personal contact between individuals is characterized in interview responses by co-presence and, as I see it, can be safely assumed to be higher in teams that meet face-to-face.

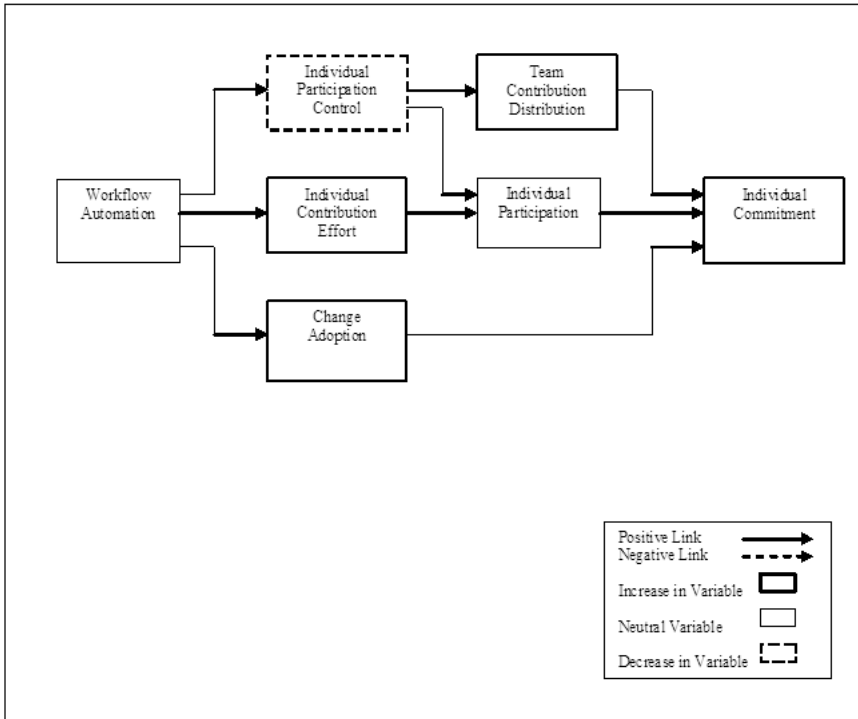
The variable *team contribution distribution*, which measures the degree of distribution of contributions among workgroup members, seems to be increased by workflow automation, apparently due to a reduction in *individual participation control*. For example, in a face-to face meeting one person, such as the group leader or participant with specific knowledge relevant to the problem domain, may dominate most of the meeting, reducing the distribution of contributions among other members (Clampitt, 2004). It seems reasonable to conclude from the evidence gathered in this AR iteration that workflow automation hinders individuals from playing such dominant roles. As discussed before, the variable *individual response time* appears to be affected by the variables *individual contribution effort*, which is increased by interaction through workflow automation, and *individual participation control*, which is reduced by workflow automation.

6.7.5. Individual Commitment

Individual commitment seems to have been generally perceived as increased by workflow automation. Structured interview and questionnaire responses indicate that three main variables directly affected the variable *individual commitment*, which refers to the individual commitment to construct a good quality response. One of these variables was *team contribution distribution*, which appears to be higher in workflow automation than in face-to-face working teams. This in turn appears to have led to an increase in *individual commitment*.

The second variable is *individual participation*, which seems to be decreased by workflow automation. This decrease appears to have led to a decreased in individual commitment. The third variable affecting individual commitment is *change adoption*, which also seems to be higher in workflow automation than in similar face-to-face meetings. The increase in this variable also appears to have increased *individual commitment*. All these variables have been discussed before, and their links with other variables are shown in Figure 6.5, below.

Fig 6.5: Path Diagram – Individual Commitment



6.7.6. Individual Response Time

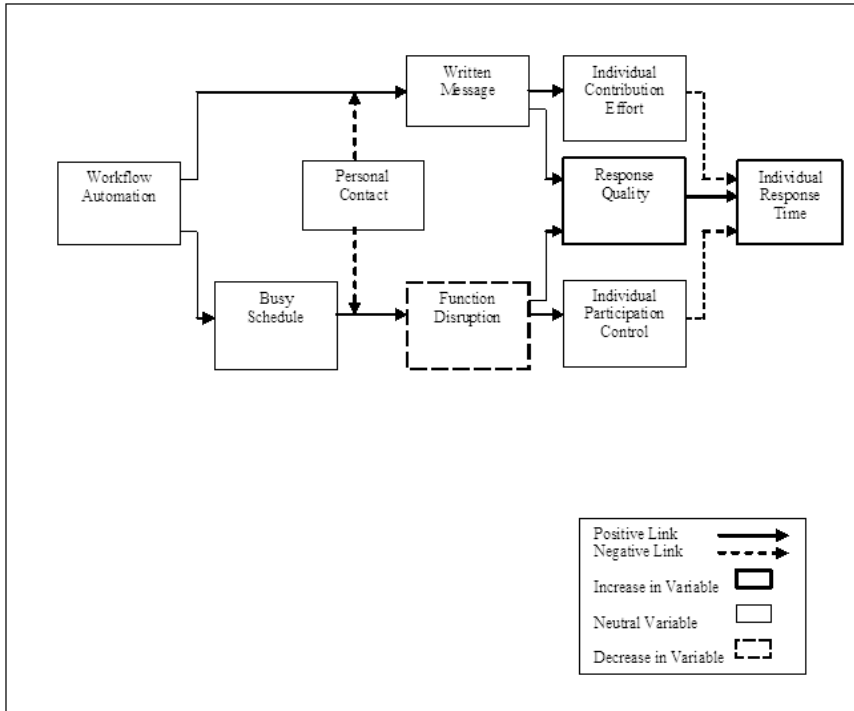
Workflow automation allows people to interact without having to compete for airtime at their own pace. This leads to a reduction in individual function disruption. On the other hand, some individuals perceive this characteristic i.e. asynchronous mode of communication, as contributing to the increase in response time.

Workflow automation leads to lower control of individual participation (i.e. response or not and after how long). This can lead to a lower level of participation. All this, plus the fact that the workflow system filters social cues and does not allow for personal “touch”, can lead to the perception that workflow automation increases individual response time.

Workflow automation reduces member work disruptions caused by answering phone calls and unscheduled meetings. This allows members with busy schedules to plan with better certainty and reliability. The perception that a reduction in uncertainty would have not otherwise

occur, leads members to perceive that the quality of response and decision-making is improved. However, this improvement in quality as a result of the written message is more demanding on the individual i.e. contribution effort, leading to an increase in individual response time. All these variables have been discussed before, and their links with other variables are shown in Figure 6.6, below.

Fig 6.6: Path Diagram – Individual Response Time



6.7.7. Individual Learning (Action Learning)

In the interview respondents' opinion, I noted that four main variables directly affect the variable *individual learning*, which measures both social and process-related learning by individuals and groups (Bell et al., 2002). These respondents' opinion generally supports the notion that individual learning is increased by workflow automation. One of the four variables mentioned by interviewed respondents is *individual sincerity*, which is perceived to be higher in workflow automation than face-to-face teams. This is seen as likely to have increased individual learning because process related problems and personal opinions, in consequence, may

have been conveyed more frankly than in face-to-face coordination meetings.

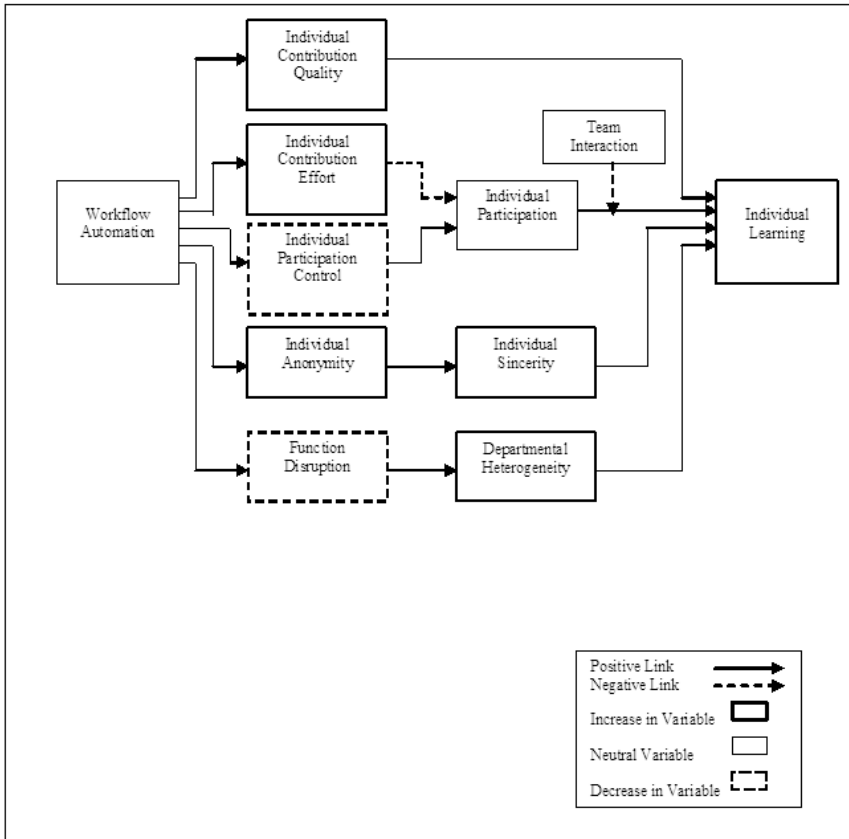
Also perceive to be increased by workflow automation is the second variable “*Individual contribution quality*”. This factor may also contribute towards an increase in individual learning, as better quality contributions are likely to contain more useful knowledge and information than poor quality contributions. The third variable is *degree of interaction* which, evidence strongly suggests, is drastically decreased by workflow automation. This factor may decrease individual learning, as it is plausible to assume that an increase in *interaction* is likely to lead to an increase in the amount of knowledge and information exchanged between individuals.

The fourth variable is *departmental heterogeneity* (i.e. how heterogeneous is the workflow as far as *functional* representation is concerned), which seems to be increased by workflow automation. An increase in departmental heterogeneity in the workflow appears to lead to an increase in individual learning due to the broadening in the scope of knowledge and information communication that an increase in departmental heterogeneity appears to contribute to.

All these variables, except *individual sincerity*, have been previously discussed in this chapter. The causal links between these variables are shown in Figure 6.7, below.

The most important factor influencing the increase in the variable *individual sincerity* seems to be the increase in individual anonymity in workflow automation. This is supported by previous research, which suggests not only that workflow automation increases anonymity, but also that this leads to people conveying their ideas more frankly (Wolfe, 2001). It has been often reported, for example, that anger and frustration are much more frequently communicated in electronic group discussions - a phenomenon called *flaming*.

Fig 6.7: Path Diagram – Individual Learning



6.7.8. Cross Functional Integration

Three main factors appear to affect cross functional integration i.e. deployment of a workflow automation practice and culture throughout the organization. The first factor seems to be related to an increase in the variable *Management support*, which reflects management support for strategic performance management of supply chain. Management support is universally recognized as of paramount importance in productivity improvement projects, whether projects involve radical or incremental process change (Camp et al., 2004). Any organizational change project will meet with resistance (Hazeltine & Bull, 2003). Thus, without the support from management, particularly at the top, cross functional

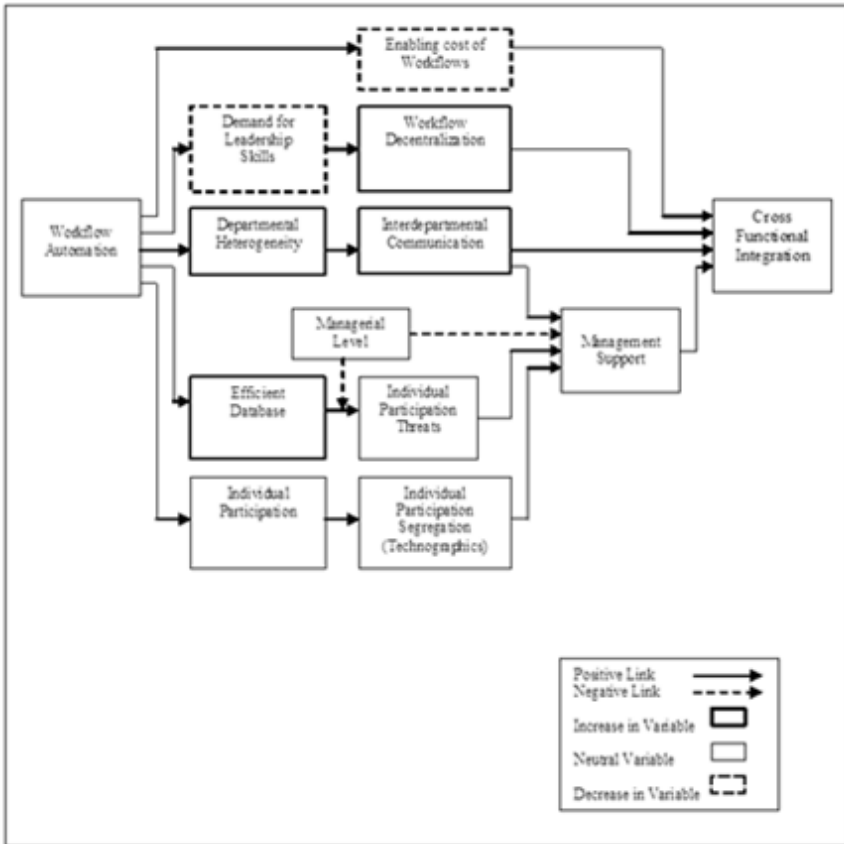
integration through workflow deployment is likely to be considerably limited.

The second factor in cross functional integration seems to be related to an increase in the variable *Workflow decentralization*, which is a measure of how well the work (i.e. customer services, coordination and expediting activities) is distributed in the organization. Sometimes management support is not enough to guarantee commitment from those who will implement the workflow or play roles in the new process as participants. As pointed out by those who defend bottom-up and top-down approaches, lack of commitment can lead to failure in the implementation of change (Shanks et al., 2003). Commitment to workflow deployment can be achieved with the decentralization of activities, as highlighted by total quality management studies (Dahlgaard et al., 2005).

The third cross functional integration factor appears to be related to an increase in the variable *Interdepartmental (Interfunctional) communication*, which is a measure of the amount of knowledge and information exchange between different departments in an organization. The importance of this factor to cross functional integration comes from the fact that workflow's organizational impact is higher when processes that cut across several functional areas or departments are implemented. That is, workflow must have enough breadth to generate organization-wide improvement (LaBonte, 2001).

This study indicates that the three factors described above are affected by workflow automation, in the context of strategic performance management of supply chain. A qualitative description of the relationship between these factors and workflow automation is depicted in Figure 6.8 below, where they are represented by the three variables *Workflow decentralization*, *Interdepartmental communication*, and *Management support*.

Fig 6.8: Path Diagram – Cross Functional Integration



The study suggests that an increase in the variable *workflow decentralization* is likely to accrue from workflow automation. The most important reason seems to be a decrease in the demand for leadership skills. In all workflows deployed, the leader is not the most senior manager in the workflow team. Moreover, two of the leaders confirmed that they had faced severe difficulties in leading face-to-face groups in the past, and that they would likely give up their leadership to more senior manager if their coordination and expediting activities were not based on workflow automation. The reduction in demand for leadership skills, combined with the considerably lower enabling cost of workflows, is likely to contribute to the growth in cross functional integration by means of workflow deployment in the organization.

Another positive factor in cross functional integration is an increase in the variable *Interdepartmental communication*. This factor is apparently caused by the higher interdepartmental heterogeneity in workflow automation. The higher interdepartmental communication, however, may lead to a decrease in the variable *management support*. This influence seems to be stronger at lower and middle management levels. Some of STS Managers at these levels seem to perceive that controlled and selective communication of information (i.e. filtering of information that flow bottom-up and top-down in the organization) as one of their most important managerial functions. The higher interdepartmental communications enabled by workflow automation may pose a threat to the maintenance of this type of function in the organization and therefore lead these managers to react to the cross functional integration workflow initiatives in a negative way. This conclusion is consistent with previous research findings on management reactions to the introduction of asynchronous computer-mediated communication systems (Bromme et al., 2005).

Three other variables, besides *interdepartmental communication*, seem to have negatively affected the variable *management support*. These variables are: *Individual participation threat*, *efficient database and workflow participation segregation*. Several members identified as a threat to them the fact that workflow automation enabled a more efficient record keeping of actual events and interactions. This perception seems to increase, in association with the level of management. Some senior managers, for example, refrained from using workflow automation even though they declared having monitored the workflow with interest (this was corroborated by their knowledge about the workflow content, shown in unstructured interviews). When asked why they had not been using workflow automation, they answered that they wanted "...to know how the medium worked...", as one senior manager put it. In another structured interview, a senior manager stated that in his opinion, neither he nor any other manager would likely send electronic messages to a whole group of people about a controversial issue. Such electronic messages, according to him, could easily be used as written evidence against their senders at a later stage (e.g. as evidence of their admission that some delays and problems have been caused by their departments).

When asked about supply chain wide impacts of large-scale workflow automation, several unstructured interview respondents, pointed out that one of the outcomes of such a project would be the segregation between those with high computer skills and those with low computer skills i.e. workflow automation is seen as likely to increase the variable

technographics. This assumption is somewhat supported by the fact that even within workflow team individuals with lower computer skills are likely to contribute less or refrain from contributing altogether.

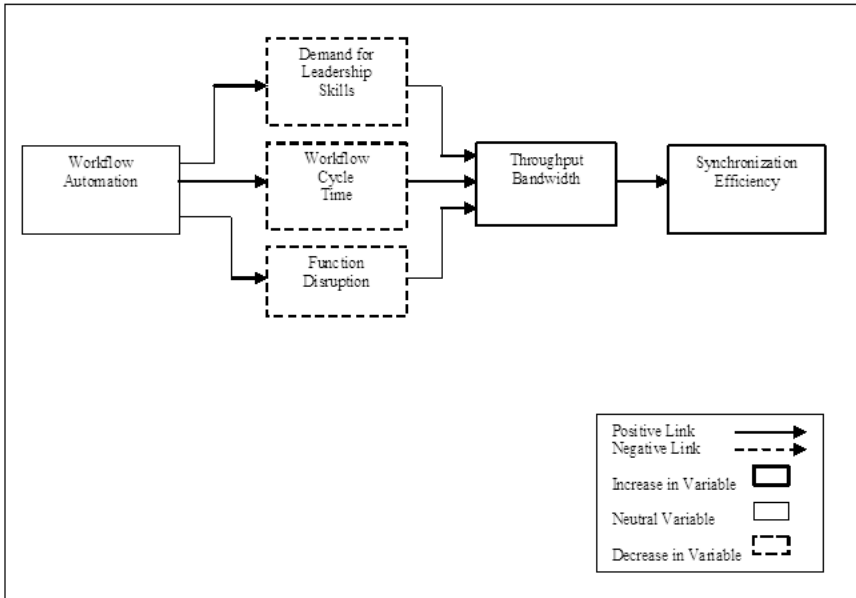
According to my data analysis, the overall impact of competing positive and negative factors on cross functional integration by means of workflow deployment is likely to lead to failure than success at STS. This is supported by factors that lead to a lack of management support. It appears that organizational workflow success would unlikely be achieved at STS without a change in the managers' perception of their role in the organization.

6.7.9. Synchronization Efficiency

The findings of this research iteration indicate an increase in supply chain performance efficiency as a result of workflow automation deployment. Two intervening variables appear to directly account for this increase – *throughput bandwidth*, which seems to be increased by workflow automation. The variable *throughput bandwidth*, in turn, seems to be directly affected by three other variables - *demand on leadership skills*, *workflow cycle time* and *function disruption* - all apparently decreased by workflow automation. These causal links are depicted in Figure 6.9, below.

The identification of the variables *throughput bandwidth* as directly affecting performance efficiency follows naturally from the definition of process productivity (Hunt, 2000) applied to the concept of collaboration. This definition focus on cycle times associated with running workflows and *throughput* capacity. *Throughput*, in turn, is linked with the "amount" of workflow that can be done per unit of time, being "number of events and interactions (i.e. concurrently)" a possible measure of this "amount" (Jia and Rajkumar, 2006).

Fig 6.9: Path Diagram – Synchronization Efficiency



The conclusion about the increase in the variable *throughput bandwidth* due to workflow automation is predominantly analytical, and follows from the primary effects of workflow automation on demand for leadership skills, workflow cycle time and function disruption. Nevertheless, one particular piece of evidence appears to provide direct support to the existence of a causal link between workflow automation and an increase in the possible number of concurrent activities per unit of time i.e. the perception by several participants that workflow automation would "enable" their respective workflows to occur, which otherwise would likely be difficult or impossible. Moreover, there are no dissenting opinions regarding this perception.

The decrease in the variable *demand for leadership skills* induced by workflow automation apparently allowed staff of relatively low status and low leadership skills (e.g. conflict resolution and coordination skills) in the organization to lead teams. This is likely to contribute to an increase in the possible number of teams per unit of time by broadening the organizational base of potential team leaders.

The decrease in the variable *workflow cycle time*, on the other hand, has a direct impact on the possible number of *throughput bandwidth* because it allows for the start and completion of more *workflows within* the same time period.

The decrease in the variable *function disruption* by workflow automation has the potential to allow for the participation of staff in workflow interactions that would normally be prevented to do so due to time constraints imposed by their respective functions in the organization. In addition, as observed in two of the workflow teams in this AR iteration, workflow automation appears to make it easier for staff to participate in more than one workflow team at a time. Not only time and physical barriers are practically eliminated, but the time spent by participants on interaction is drastically reduced.

6.7.10. Synchronization Effectiveness and Competency

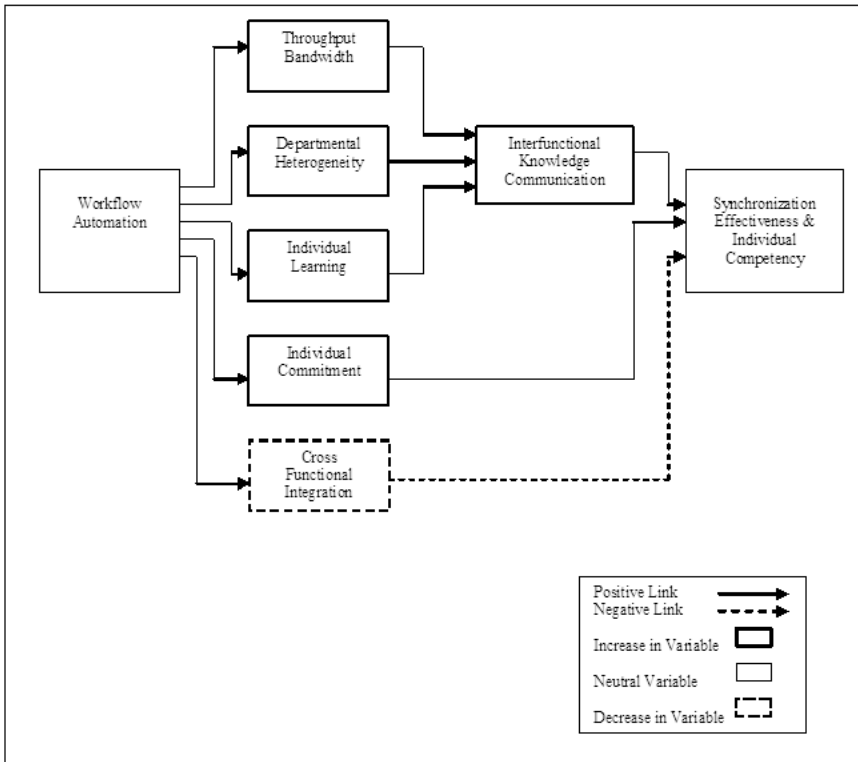
My experience in this and the two previous research iterations suggests that the benefits of workflow to an organization cannot be properly understood only by looking at direct and immediate process improvements brought about by workflow automation. There seems to be at least three types of benefits:

- a) There are the direct benefits i.e. the most easily identifiable ones. These are message & response quality, synchronization efficiency, and workflow set up cost reduction. Improvements directly accruing from the deployment of workflow automation,
- b) There are knowledge sharing benefits, which follow from the exchange of socio-technical knowledge i.e. knowledge about processes and social structure in the organization (Schwandt & Marquardt, 2000), that occurs during coordination and expediting problem solving workflows. These benefits result from knowledge and information sharing across intra and interdepartmental functions, which has been identified as a key factor influencing organizational competitiveness, particularly in Learning organizations (Shani & Docherty, 2003) and
- c) There are organization cultures building benefits accruing from the fostering of a culture of continuous improvement, as workflow deployment is achieved throughout the organization and supply chain (Detert et al., 2000).

At this stage, ideally, these three types of benefits must be considered in the assessment of synchronization effectiveness. In this sense, even though a number of workflows may not be effective individually, the

related workflow modeling and documenting efforts may still be effective for supply chain synchronization. A single workflow model targeting core organizational processes (i.e. customer facing) may lead to drastic productivity gains that considerably improve how the organization stands among its peers and competitors. Without a culture of continuous improvement (Fairfield-Sonn, 2000), the higher competitiveness achieved may not be sustained over the long run, as the competition catches up.

Fig 6.10: Path Diagram – Synchronization effectiveness



A direct corollary of the conceptual augmentation discussed above is that the potential of workflow automation to improve *synchronization competency* of the supply chain manager as a result of the increase in inter-functional knowledge and information dissemination throughout the supply chain (Cunningham et al., 2000). This function of workflow automation in supply chain must be considered in the assessment of its effect on synchronization effectiveness. The explanatory causal model in Figure 6.10 reflects this, by proposing that organizational workflow effectiveness is directly affected by the variables *inter-functional*

knowledge communication, individual commitment, and cross functional integration.

Although the new extended perspective of the variable *synchronization effectiveness* discussed above provides a broader scope for the assessment of effects on this variable, the evidence from this research iteration does not clearly suggest either an increase or a decrease in this variable due to workflow automation. The evidence gathered during this research iteration points towards an increase in the variable *inter-functional knowledge communication* due to workflow automation. This increase appears to be caused by a simultaneous increase in three other variables as a result of workflow automation. These variables are *throughput bandwidth, departmental heterogeneity, and individual learning*. To say that there is a simultaneous increase in these three variables implies that workflow automation would potentially occur more often than similar face-to-face meetings, involving more departments (and thus probably more functions), and contribute more towards individual learning than similar face-to-face meetings. This seems to naturally suggest an increase in inter-functional knowledge communication.

In my view, the increase in individual commitment through workflow automation is likely to have a positive impact on *synchronization effectiveness* by increasing the chances that *change adoption* will be implemented. The evidence gathered in this AR iteration, however, neither provides strong support to the assumption that there is an actual increase in this variable (although a large number of respondents perceive such an increase), nor suggests that this possible increase is anywhere near drastic. I nevertheless decided to maintain *individual commitment* as an intervening variable in the causal model for completeness.

As a final remark about the causal model linking workflow automation with synchronization effectiveness, it appears that the decrease in the variable cross functional integration induced by a lack of management support in STS (see explanation in 6.7.8 above) has the potential to negatively affect synchronization effectiveness by hindering the building of a "Participative Problem Solving Culture" in the organization.

6.8. Comparison with previous iterations

As with the second iteration of the AR cycle, the findings relating the workflow automation effect on strategic performance management of supply chain summarized above covered aspects that are considerably different from those discussed in the first iteration of the AR cycle. This

is mainly due to due to the difference in the scope of the interventions. Although the organizational scope of the AR intervention is broader in this research iteration than in the second, it is still considerably narrower than in the first, i.e. only one organization is involved in this research iteration, which prevented the gathering of direct evidence regarding network-wide workflow automation effects. Nevertheless, the findings of this research iteration are generally consistent with those of the first.

One possible exception to this consistency of findings obtained across the first and this research iteration is the warning signs from this iteration indicating that cross functional integration by means of workflow deployment is ultimately hampered by lack of management support. Although consistent with findings from the second research iteration, this is contradictory with the remarkable improvement in the first iteration. A possible explanation for this contradiction, offered in Chapter 5, was the influence of support from the chief operating officer as a factor exerting a strong positive influence on cross functional integration by means of workflow deployment. Although lacking enough support, this explanation is still adopted here by exclusion i.e. I have been unable to produce any other plausible explanation based on the evidence at hand.

The findings in this research iteration are generally consistent with, and considerably refined those drawn from the second iteration. The variable *cross functional integration* warrants a special mention in this respect, as it results from a re-conceptualization of the variable *Team formation for Collaborative Workflows* (in the second iteration). This re-conceptualization leads to the identification of a number of intervening variables that are not present in the explanatory causal model generated in the second iteration.

6.9. Chapter summary and concluding remarks

This chapter reports on the third iteration of the AR cycle whereby all workflows are modeled and deployed over a period of 3 months. The client organization in this research iteration is STS, the Singapore operations of a European tool steels company.

The findings of this research iteration suggest that the workflow cycle time can be reduced by workflow automation. The main reason for the reduction in the workflow cycle time (generally seen by participants) is the reduction of set up time (i.e. the time required to bring people physically together). This factor tends to offset the negative effect that workflow automation have on individual response time, due to a higher

individual contribution effort (especially for participants lacking in computer skills) and to a lower individual participation control (i.e. it is easier for a participant not to contribute when the interaction is not face-to-face).

Demand for leadership skills seems to be lower in workflow automation than in face-to-face meetings. In workflow automation, leaders do not have to be as competent as they would have to be in face-to-face meetings in tasks such as resolving conflicts between different parties, coordinating team work, preventing the team from steering away from its initial goal, or making sure that the team follows a pre-defined protocol. The main cause for this is a decrease in individual influence and an increase in change adoption, both apparently caused by workflow automation.

There is an improvement in the quality of message and response generated by participants induced by workflow automation. This seems to result from a difference between negative and positive factors. The main negative factor associated with workflow automation is lower individual participation. The main positive factors are lower individual stress, higher site and departmental heterogeneity in the workflow, higher quality of individual member, higher team focus, and higher individual access to information relevant to the workflow activity.

Individual satisfaction does not seem to be affected by workflow automation in a decisive way. This results from a balance between positive and negative factors. The main negative factors are lower degree of interaction, higher individual response time, and lower or no personal contact. The main positive factors are lower individual stress, better distribution of individual contributions, and lower disruption of individual's routine work.

Individual commitment to workflow responses seems to increase with workflow automation. This seems to occur due to a better distribution of member contributions, and a higher change adoption, according to respondents' perceptions. These factors seem to offset the negative effect of lower individual participation caused by workflow automation.

Socio-technical learning also appears to be increased by workflow automation. This is apparently due to better quality of individual contributions and higher individual sincerity, which seems to offset the negative effect of lower degree of interaction caused by workflow automation. This study suggests that the cross functional integration by

means of workflow deployment may be hampered by lack of management support. The reasons for this at STS seemed to be:

- a) Lack of management support caused mainly, by the higher perceive threats brought about by workflow automation,
- b) Reduction of lower and middle management control over information flow, which leads to lack of support of workflows by these managers and
- c) Segregation (technographics) of staff with low computer skills from staff with high computer skills in the organization.

These negative effects may outweigh the positive effects of higher interdepartmental communication, higher decentralization of workflow automation initiatives, and lower organizational cost of workflows that follow from workflow automation.

The findings relating the workflow automation effect on *synchronization efficiency* in this research iteration are considerably different from the ones discussed in the first iteration of the AR cycle, particularly due to the difference in the scope of the interventions and in the availability of process-related and workflow history information. Nevertheless, the findings of this research iteration are generally consistent with those of the first in pointing to an increase in organizational workflow efficiency.

There is not enough evidence, however, pointing to an increase nor decrease in *synchronization effectiveness*, which has been re-conceptualized to account not only for immediate process improvements brought about by workflow automation, but also for knowledge sharing and participative problem solving culture building benefits. In the light of this re-conceptualization, *synchronization effectiveness* is then seen as directly affected by the variables *inter-functional knowledge communication*, *individual commitment*, and *cross functional integration*.